

## Concept: Deterministic Process

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<sup>3</sup> *Keywords:* Digital Signal Processing

## 4 1. Definition and Introduction

5 A deterministic process is one which can be described in such a way that knowledge of a sample of a  
6 signal from the past enables exact prediction of the value of the signal at a given future instant. Examples  
7 are processes which can be described by rational expressions. An example is the function

$$x(t) = A \sin(\omega)t \quad (1)$$

Given  $A$  and  $\omega$  one can predict the value of  $x$  for any desired value of  $t$ . Conversely, given the relation between  $x$  and  $t$ , plotted out for several values of  $t$ , our task as Diagnosticians would be to find the above neat expression which would allow us to understand the behavior of  $x$ , and therefore to predict its value at future values of  $t$ . Not all deterministic processes are so obvious. Some take lots of sorting and analysis, and often some inspired guesswork. Often we have to give up in frustration, and declare that the process is non-deterministic: knowing what happened every day in the past to the Dow Jones Index does not allow us to predict the closing value 3 days from today, let alone next month. We will have to settle for descriptions in terms of statistics, probabilities, uncertainties and margins of error. Before we delve into statistical techniques for representing non-determinate processes, however, it is useful to remember something:

17 A "random" process becomes a deterministic process if one finds the entire physics of the process. Of  
18 course, this is considered to be "impossible" for many complicated processes (the stock market, turbulence,  
19 final exam questions...) but we keep trying. There is reason for hope. Consider the series of digits:

20 1, 4, 1, 5, 9, 2, 7,....

<sup>21</sup> Looks pretty random, huh?

22 Would you believe that (a) this series goes on for thousands of digits, and (b) it can be described by a  
23 very simple, closed-form analytical expression from which every digit and its location(s) in the series can be  
24 predicted? Its true: try guessing it.

25 Hint: Try subtracting 3 from the value of Pi, and then look at the digits.

<sup>26</sup> **2. Significance of Deterministic Processes**

<sup>27</sup> If a process is deterministic, one can hope to develop a predictive algorithm for it. This will allow exact  
<sup>28</sup> determination of future conditions.